Biological Monitoring of Macroinvertebrate Communities to Assess Acid Mine Drainage

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Acid mine drainage (AMD) occurs when pyrite or other sulfide minerals associated with metal deposits and coal seams are exposed to water and oxygen. A series of chemical reactions may result in highly acidic mine water discharges and elevated concentrations of dissolved metals. These discharges are often characterized by high-frequency diurnal variations and seasonal effects. AMD can alter the abundance, taxa richness, diversity, and species composition of aquatic organisms including fish and macroinvertebrates. This paper identifies changes to the benthic macroinvertebrate communites in AMD-affected streams of the western United States.

The effects of AMD depend on several variables including geology, geochemistry of the mine site (overburden, ore body), and baseline population dynamics. At pH levels below 6, trace metals (e.g., arsenic, cadmium, copper, mercury) increase in solubility and bioavailability, and thus moderate AMD conditions (pH 3 to pH 6) are often associated with the dominance of acid/metal-tolerant organisms. Severe AMD (pH < 3) is detrimental to almost all macroinvertebrate populations. Downstream of AMD discharges, where acidity is neutralized by dilution or buffering, increased oxidation can cause the precipitation of metal hydroxides onto the stream substrate, thereby reducing viable habitat and oxygen supply to fish and benthic organisms.

Monthly or quarterly water quality sampling alone may not accurately reflect acute changes in the frequency and range of pollutants discharged from AMD sites. Thus, biological monitoring of macroinvertebrate communities is one management tool for assessing AMD discharges and can contribute to the understanding the multiple effects of AMD on aquatic ecosystems.